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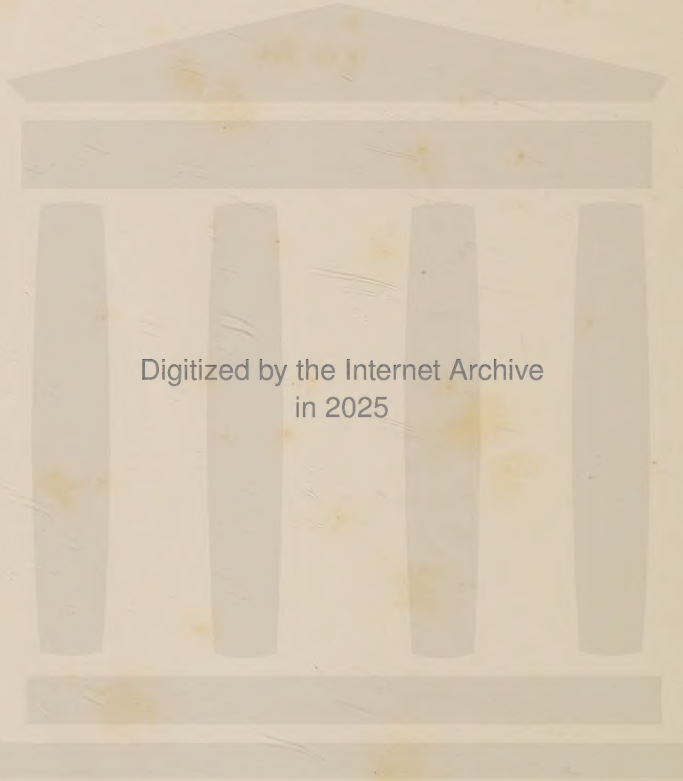
The High Seas Tuna Fishery
of California

By

H. C. GODSIL

California State Fisheries Laboratory





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FOREWORD

The information imparted in this article has been acquired incidentally in the course of an active participation in many phases of the tuna industry, ashore and afield. To the innumerable people who have contributed data I express my sincere appreciation, especially to Captain Paul Verney and his crew on the tuna vessel, *Reliance*.

The following three people, each an authority in his field, have contributed greatly to the accuracy of the information contained in this report. Mr. W. V. Ambrose of the Westgate Sea Products Company of San Diego most kindly read the manuscript and checked all statements pertaining to the business and administrative aspects of the subject. Mr. Paul Blackwell of the Campbell Machine Company, San Diego, likewise checked facts and figures relative to machinery and equipment; and Mr. David Campbell also of the Campbell Machine Company, perhaps unknowingly, has contributed materially to this article by willingly answering a vast array of questions over a considerable period of time.

Whereas the writer is solely responsible for all statements made herein, the generous cooperation of these three gentlemen has to a large extent assured the accuracy of the following description.

CONTENTS

	Page
Introduction -----	7
The Tuna Boat -----	10
Description -----	10
Financing -----	16
Crew -----	17
Catching Bait -----	18
Fishing Tuna -----	23
Preservation of the Catch -----	33
Disposal of the Catch -----	35
The Present Tuna Fleet -----	37
References -----	41

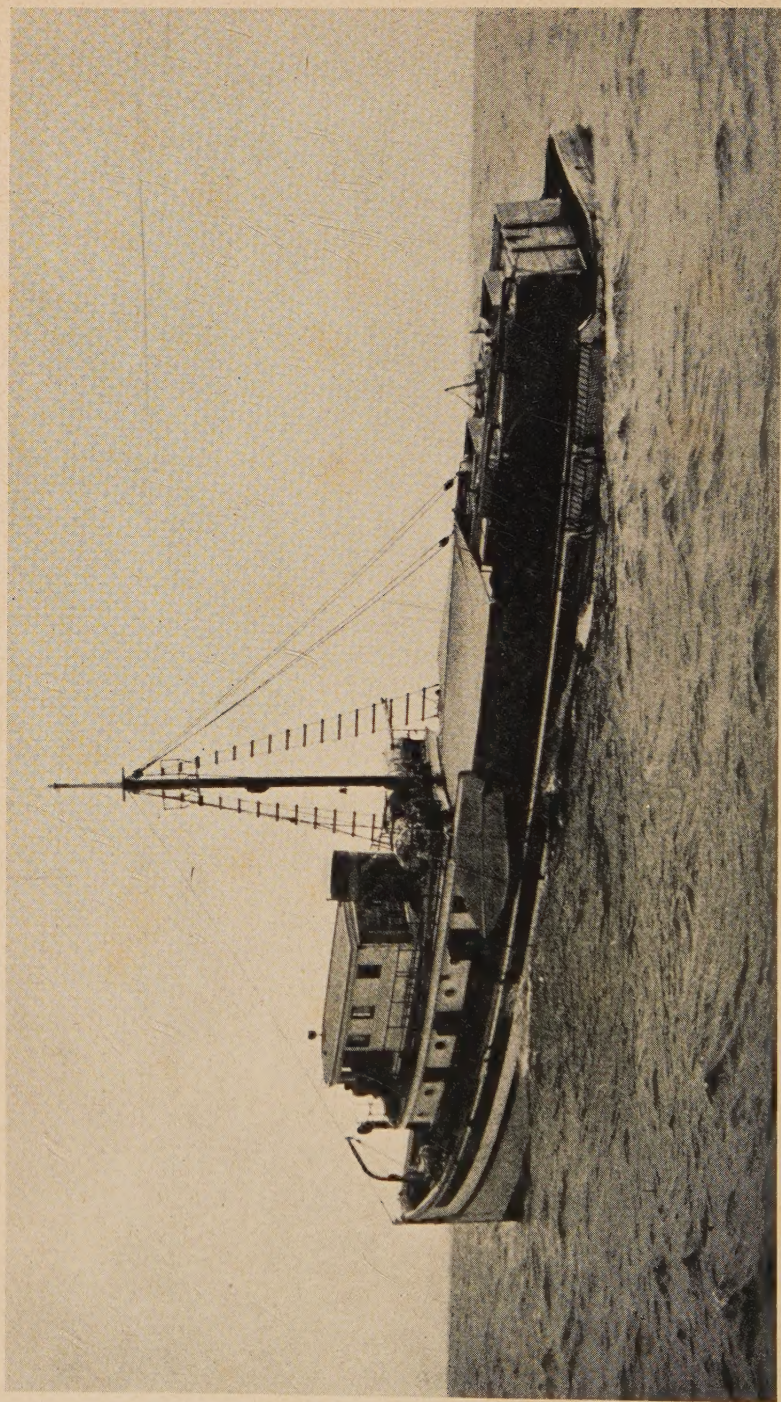


FIG. 1. Drifting on the fishing grounds. When fishing is over for the day, tuna vessels often remain on the grounds drifting overnight. At such times they have a knack of broaching to the sea or swell and lie rolling in the trough, with decks awash. Note the skiff lashed to the shrouds which was the common way of carrying the tender in the earlier days. Photograph by author.

THE HIGH SEAS TUNA FISHERY OF CALIFORNIA ¹

By H. C. GODSIL, California State Fisheries Laboratory

INTRODUCTION

The following paper has been compiled as an answer to the innumerable questions constantly asked by an interested public about the tuna fishery. Whereas the tunas of this coast are now the object of a biological study by the California State Fisheries Laboratory, this paper is in no sense a contribution to this study. It is merely a limited description of the fishery and the boats engaged therein.

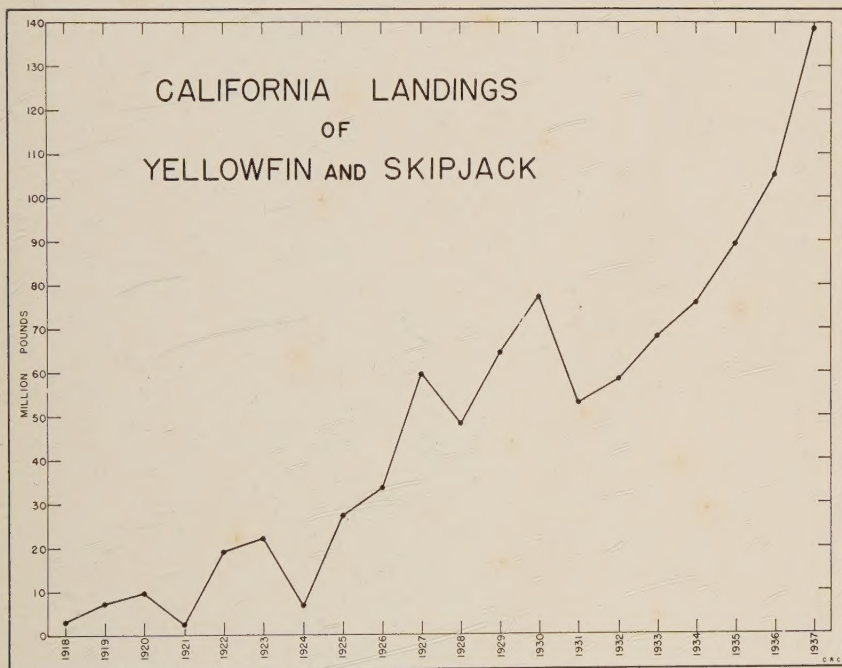


FIG. 2. Annual landings of skipjack and yellowfin tuna in California. The graph includes only the catches made by California boats, i.e., exclusive of deliveries of frozen fish imported from Japan and Hawaii.

It is limited because it covers only one—the most important, the most interesting and most spectacular—branch of the tuna fishery, namely the high seas live bait fishery for skipjack and yellowfin tuna. Both these species are also caught by purse seine boats and by small live bait boats fishing in local waters, but their catches are minor and erratic. It is the steady deliveries of the larger bait boats throughout

¹ Submitted for publication, January, 1938.

the year upon which the industry depends. In actual value of the product, tuna is second only to salmon on the entire Pacific coast. In tonnage landed, it ranks second in the fisheries of California. In 1936 the total pack of tuna approximated 2,600,000 cases. The combined total catch of yellowfin tuna and skipjack made by our local fleet in recent years is shown in figure 2. Virtually the entire catch of these two species is canned in southern California, with San Diego and San Pedro as the home ports of the fleet. Negligible quantities are sold to a limited fresh fish trade.

There are five so-called tunas² taken in California and each supports a fleet of more or less specialized boats which contribute to Cali-

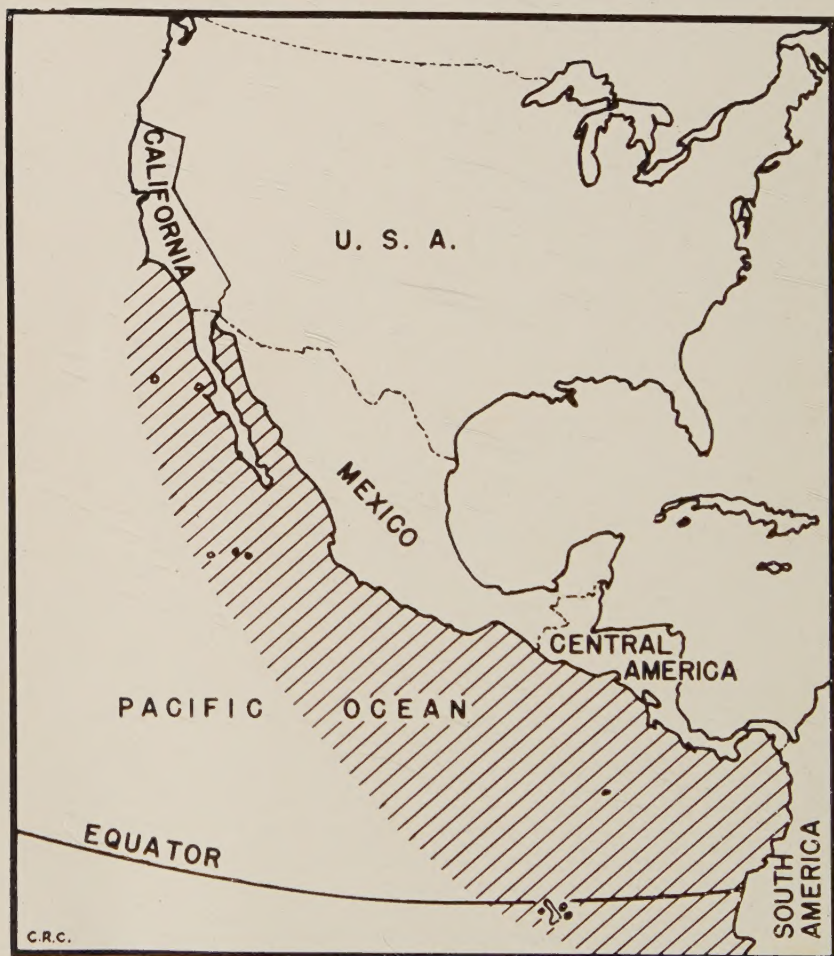


FIG. 3. Map showing the area fished by the California tuna fleet. Although fishing localities vary with the seasons, tuna boats are nearly always to be found scattered throughout the region denoted by the cross-hatching.

² Yellowfin tuna (*Neothunnus macropterus*), skipjack (*Katsuwonus pelamis*), albacore (*Germo alalunga*), bluefin tuna (*Thunnus thynnus*), and bonito (*Sarda chiliensis*).

fornia's tuna pack. Descriptions of these fisheries may be found elsewhere (see list of references at end of text), but the present account pertains exclusively to the live bait, hook and line fishery for yellowfin and skipjack followed by the larger boats.

The tuna fleet comprises about 70 boats, built at a cost approaching \$6,000,000. According to the size of the individual vessel, this fleet may be divided arbitrarily into two parts. Those under 90 feet are herein referred to as the "smaller tuna boats" and these will be discussed only incidentally. Those over 90 feet are designated as the "larger tuna boats," and the 50 vessels comprising this fleet are essentially the subject of this article. All statements and descriptions apply therefore to a representative average of this fleet.

These tuna boats are the largest fishing vessels registered in this state and they were expressly designed and built to exploit the most extended fishery on this coast. On a single trip of perhaps seven or eight weeks they may travel a total distance of 6000 to 8000 miles and range 3000 miles from home. Necessarily, they are large for they must accommodate sufficient fuel capacity, a refrigerated fish hold that will carry a paying load, and a crew large enough to catch it. Their fuel capacity ranges from 10,000 to 30,000 gallons; their fish capacity from 150 to 350 tons; and the size of crew from 12 to 20 men, according to the size of the vessel.

Almost any day at San Diego one of these tuna boats may be seen preparing for a trip. With all repairs completed, she proceeds to the fuel docks where the tanks are filled with diesel and lubricating oil. From here she proceeds to the icing dock. Three-hundred-pound blocks of ice are transferred from the waiting trucks to the conveyor and carried by this to the crusher overhead, from which they pour in an endless stream of fine particles to the blower beneath. This blower is used to distribute the ice uniformly to the farthest corners of the hold, thus eliminating much unnecessary shovelling.

Meanwhile, loads of provisions and miscellaneous stores come aboard and the erstwhile trim tuna boat now takes on a dishevelled look of chaos, with crates and bales and boxes piled everywhere. Late in the afternoon order is restored and the vessel is deserted except for one or two who keep the engine watch, for with the taking on of ice an auxiliary is started to run the refrigerating plant and bait pumps, and one or the other auxiliary runs continuously for the duration of the trip. The sailing time is set and the remainder of the crew has gone ashore to spend the intervening time at home. Later in the evening the tuna boat will sail. With three long blasts on the whistle, a last farewell to the families and friends ashore, she heads for sea. The long trip has begun.

THE TUNA BOAT

Description

The modern high seas tuna boat has evolved from the small local live bait boat. The latter is a flush deck vessel with low freeboard aft, with the engine amidships or slightly forward, with a large clear after-deck on which stands the single bait tank and where all the work is done, both bait hauling and fishing. Invariably there is a trunk cabin forward, rising to full head room over the engine to provide a glassed-in shelter from which the boat is steered and handled. Beneath the trunk cabin forward are accommodations consisting simply of a forecastle with tiers of bunks for the crew. Toilets and galleys are conspicuous by their absence. On the daily trips the fish caught are merely left in bins on deck and covered with moistened burlap. If and when these boats go out for more than a day or two they take a few blocks of crushed ice in a small hold abaft the engine.

As the boats grew in size to follow tuna increasing distances south, certain changes were introduced into the newer hulls. The design remained fundamentally the same but the engine was moved progressively forward to increase the size of the fish hold aft, and so the fish carrying capacity, at the expense of the accommodations forward. But the increase in length provided sufficient deck space forward for an appreciable deck house. By moving the controls to the forward end of the house, there was room for a small galley and forecastle in the space remaining. The space below deck formerly occupied by the forecastle was then used for additional fuel tanks to provide the increased cruising radius for the longer trips southward.

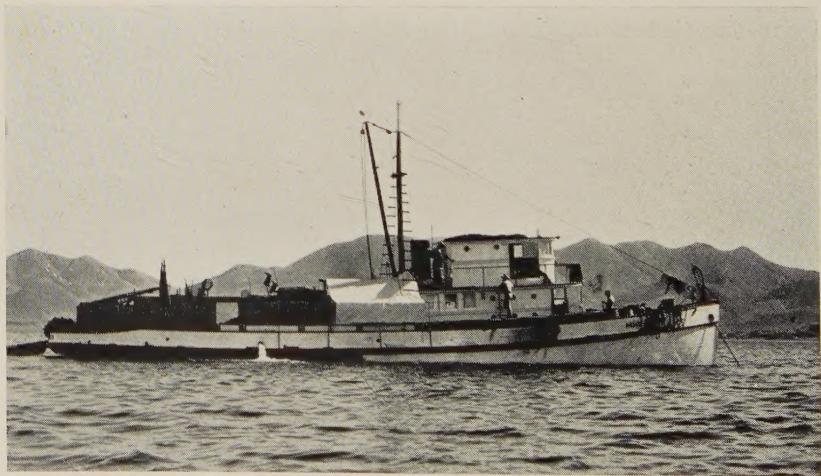


FIG. 4. A tuna boat at anchor in Magdalena Bay. This vessel is typical of the fleet of flush deck tuna boats built during the early days of the expansion of the high seas fishery, 1927-1930. Note the live bait tanks on the after deck, the bait net at the extreme stern, the awning over the hatch and the fishing poles and other gear atop the bait tanks. Photograph by D. H. Fry, Jr.



FIG. 5. A raised deck tuna boat at San Pedro. This 120-foot boat is typical of the early raised deck vessels built in 1930. Photograph by Richard S. Croker.

The next step was logically the moving of the pilot house on to the roof of the deck house, which provided more space and better visibility. Still, the boats were wet in heavy weather. To offset this and give greater freeboard forward, the roof of the main deck house was extended all the way forward as a deck, and the side planking built up as a superstructure to form a conventional forecastle head, with the forecastle deck extending aft as the roof to the main deck house. Such, in essence, is the tuna boat of today. Many minor changes have been made. Thus the skiffs are now carried amidships on the upper deck. Part of the accommodations have also been moved up to this deck, and in some cases the pilot house has been placed higher yet on top of the upper deck house. Bait tanks have increased in size in proportion to the carrying capacity of the hull and the machinery has increased in amount and complexity many fold, with the result that the tuna boat today bears little resemblance to the small local live bait boat from which it sprang.

Whereas the larger tuna boats range in size from roughly 90 to 130 feet over all, the modal or most typical length is about 120 feet. Such a typical representative of the fleet will be used as a basis of the following description, bearing in mind that considerable variation exists in detail from boat to boat. In consequence the statements to follow must be accepted as generalities and as approximations to the average.

The general arrangement of the hull follows the lines sketched above. The raised or forecastle deck extends slightly abaft of amidships. On this deck are the pilot house, radio shack and the captain's quarters, with one or more double staterooms or a forecastle for the crew. The funnel projects through the deck abaft the house and aft of this, slung in davits, are the power boat and skiff. A single mast

is stepped amidships at the break of or projecting through the upper deck. On the main deck are the engine room trunk with duplicate 5x5-inch ammonia compressors in the wings, galley and cold storage box for provisions, a single large athwartship forecabin, toilet and washroom, and lockers for bosun's stores and fishing tackle. In the newer boats and those now building, the wings of the engine room trunk house a lathe and drill press. Below the main deck the hull is occupied entirely by fuel and water tanks, machinery space and fish hold. Aft the chain locker there are usually fuel tanks followed aft by the engine room. This is generally large and spacious for it houses a disproportionate amount of machinery. The main engine is a 400- to 450-horsepower diesel, and as all vessels are single screw this stands amidships. The engines are reversible and coupled directly to the shaft. On each side of the main engine in the wings is a smaller diesel of 50 horsepower or thereabouts, each driving a 35-kilowatt electric generator. Either forward or aft of each auxiliary is a bait pump, electrically driven, and of the "axial flow" or centrifugal type. These pumps lift sea water through an 8- to 10-inch suction on the bottom of the hull and pump it to the bait tanks and wells. Stowed conveniently about the engine room is minor equipment of miscellaneous kinds.

Aft the engine room and separated from it by a bulkhead, is the fish hold. This continues aft to the shaft log, over which is usually one or more tanks for fuel or drinking water. The fish hold is insulated overhead with 3-inch sheet cork laid below the deck between the beams. The sides are sometimes similarly insulated to the turn of the bilge and ceiled over with planking. Below this the sides and floor of the hold are planked but rarely insulated. Extending the



FIG. 6. A new "all brine" tuna boat. The brine boats differ little in appearance from ice boats; the essential differences are in the hold. The brine coolers are on the forward end of the bait tanks, although they do not show to advantage. Photograph courtesy of the Sensor Studios, San Diego.

length of the hold amidships and rising 12 to 16 inches above the floor, is the shaft alley. This is boarded over with removable planks and forms the floor of the hold amidships.

Overhead below the beams are invariably grids of welded ammonia coils on 6- to 10-inch centers. The direct expansion system is used throughout the fleet. Athwartships in the hold may be one or more partial partitions and these are similarly banked with coils. In all cases the forward bulkhead separating the engine room, and in some cases though not invariably, the sides of the hold carry banks of coils, and two or more coils run the length of the shaft alley paralleling the shaft where considerable heat is generated by the bearings. The refrigeration system serves to remove the heat leaking through the hull, protects the ice indefinitely from meltage, and when fish are stowed below supplements the latent heat of fusion of the ice in removing the initial body heat of the fish. The final temperature of the fish in the loaded hold varies roughly from 15 to 32 degrees F., depending upon proximity to the coils. Normally one compressor is sufficient to maintain storage temperatures, but on the fishing grounds following a heavy daily catch the second stand-by machine is often operated in addition, to aid in removing rapidly the body heat of the fish.

A recent development, though not recent in origin, is a brine immersion system for the preservation of the catch; and the typical boat of this size has today one or more of its bait tanks or wells equipped with such a system. In this the tank is filled with chilled sea water, into which the fish are dumped in bulk, the density of the water providing relative buoyance for the fish and thus protecting them from physical damage due to the weight above. The interspaces between the fish are thus completely occupied with chilled circulating sea water, providing a more intimate contact with the refrigerant, a more rapid heat transfer and a greater uniformity in temperature than is possible under present circumstances with ice.

This system requires, in addition to greater auxiliary power, a brine cooler which is usually located on top of the bait tank. This cooler is essentially a "shell and tube" condenser with ammonia flowing constantly over the water pipes. Regulation of both the flow of ammonia and the flow of sea water through the cooler is practiced to maintain the temperature of the sea water between 28 and 32 degrees F. Whereas the same water is circulated constantly from the tank through the cooler and back, chilled again, to the tank, an overflow through the coaming is provided and a small regulated stream of fresh sea water is added constantly to replace the overflow. The purpose of this is to remove the blood as it gradually leaches from the fish and thereby keep the water in the tank clear and clean. The system requires close attention but works very satisfactorily, saves time and labor on the fishing grounds, and when operated properly results in excellent quality of the fish delivered. Five of the newest vessels in the fleet are now carrying their entire catch in brine, using the bait wells, bait tanks and other watertight compartments in the hold for this purpose.

Bait tanks are among the more conspicuous features of a tuna boat. Essentially they are large caulked wooden tanks filled with running sea water and used for retaining alive the small fish used for

bait and chum in tuna fishing. In principle the tanks have changed little, but in size they have grown with the length of the boat with a division into two and ultimately three compartments or separate tanks. These tanks stand upon the afterdeck where all the fishing is performed. They extend forward a distance of 40 feet more or less from the stern, with a passageway three to four feet wide all around between tanks and rail. In height they approximate six to seven feet with the forward tank usually higher than the after two. Access to each tank is through a central hatch, furnished with a two-foot coaming all around. The level of the water in the tanks extends up into the coaming, which thus serves to prevent the slosh of water overboard. In some of the more recent boats, steel tanks, insulated and enclosed in wood, are used both on deck and in the hold.

Through these tanks sea water is circulated constantly by a bait pump. There are two of these, but normally only one is used. Each operates through its own inlet in the bottom of the hull but the outlets from both pumps fuse on deck in a large single pipe which runs aft the length of the tanks, the size of the pipe diminishing as each of the two forward tanks receives its share.

The amount of water contained in these tanks is tremendous, approximating in a typical case to 140 tons. When the first of the larger boats of the present fleet were building in 1926 to 1930, it was feared that this great deck load would seriously impair the stability of the hull. Tank and bait capacity was essential but it was, within limits, immaterial how the needed volume was obtained. Hence, it was decided by the builders to place one-third to one-half the tanks below decks in the hull, thereby lowering the center of gravity of the whole. A transverse section of the fish hold was boarded off and reinforced and converted into two distinct watertight compartments separated by the shaft alley amidships. Each was provided with circulating water and a hatch, and thus originated the so-called "bait wells." A bait well is any compartment within the hold used for carrying bait, whereas a bait tank (or box, as it is sometimes called) is a comparable structure located on the deck. On the outward trip these wells are used for bait, but as the load of tuna is secured and the hold fills, the remaining bait is transferred from the wells to tanks on deck. Ice is transferred to the wells (which are equipped with refrigerating coils) and tuna loaded into these as in the remainder of the hold.

All the earlier larger boats were thus built with wells. Two bait wells with two tanks on deck became the conventional design. Whereas these boats possessed adequate stability and fished successfully, the design possessed inherent though minor inconveniences. Because all the chumming is done from the deck tanks, it is necessary to transfer bait from the wells to the tanks above as these become depleted of their supply. Moreover, the ice required to preserve the tuna in the wells is of necessity carried in the hold on the outward trip, and as the hold fills up with tuna a congested condition results, involving the repeated transference of ice from place to place in order to secure the needed room to work. Finally the ice has to be moved from hold to wells, as the latter are loaded with the catch.

To obviate this, individual crews began to remove their wells and to replace them with a third and larger tank on deck. The movement

gained momentum and it was not long before the majority of boats had eliminated wells entirely. The trend was accompanied if not checked by some disasters and a tragedy. Two boats capsized and a third was lost with all hands, while others of the present fleet are tender to the verge of instability.

Meanwhile, the use of chilled sea water for the preservation of the catch gained rapidly in popularity. The majority of the boats installed this system in the largest (forward) bait tank, in which tuna had hitherto been carried on the homeward trip in crushed ice. The success of this system placed a premium upon all watertight compartments, and the few boats still retaining their original bait wells were quick to adapt these to the new brine system, whereby they were enabled to carry almost half their load in brine, whereas those boats which had removed their wells could not increase their capacity to carry fish in brine without reinstalling bait wells or other watertight compartments in the hold. Although few if any boats replaced their wells, all boats then building or subsequently built included wells in the plans, and some of the newest vessels have the entire hold divided into watertight compartments so that the entire load is carried in chilled sea water. Such an arrangement gives these boats a greatly increased bait capacity in the hold, obviating the necessity for the massive tanks on deck. In consequence the newest boats carry only two tanks on deck and these are considerably smaller than hitherto used.

A matter intimately associated with tanks and loads is freeboard. The almost total absence of freeboard aft is the most striking feature of a tuna boat. Loaded and ready for sea, a tuna boat has its afterdeck awash, or at most, inches from the water. Because of the type of fishing gear used and the size of the fish handled, this is a necessity as will be explained in a later section. Being a necessity it follows that the combined load on and under the afterdeck must equal the displacement of the after body. Too large a bait tank would immerse the stern whereas too small a tank would result in excessive freeboard.

There is therefore a definite relationship between the capacity of the bait tanks and the displacement of the after portion of the hull. Any wide departure in this relationship necessitates an adjustment in the load carried in the hold. Such an adjustment has of necessity been made in those boats carrying the entire catch in brine. A vessel floats by virtue of its reserve buoyancy, so were the fish hold of a tuna boat filled with sea water, the reserve buoyancy would vanish and the stern would be waterlogged. Any additional weight now placed on the afterdeck would submerge the stern, hence the vessel has lost all capacity to carry any bait tank. As bait tanks are desirable, it is essential to lighten the load carried in the hold in proportion to the weight of tanks on deck. And this has been done in the "all brine" boats by the disuse of the space amidships over the entire length of the shaft. The hold wells extend from the skin to within three feet or so (differing in the different boats) of the center line, leaving a continuous alley or passageway from the engine room bulkhead to the stern. In this alley run the shaft and all the piping, and from each well opening to the alley is a watertight door through which fish may be unloaded if desired, so that as long as space within the hold must be sacrificed for buoyancy, this is the most convenient course to pursue. The volume of

this alleyway is very roughly that of the bait tanks, thus providing the necessary buoyancy to float this weight.

A solid 34-inch rail extending completely around the main deck completes the picture of a tuna boat. This rail functions as a bulwark and serves besides to retain the fish on deck until they can be stowed below. Such is the modern tuna boat—squat and picturesque. Built to exacting requirements and greatly overburdened with a hundred tons or more of water on the afterdeck and almost as many tons of fuel and machinery forward with little in between, it is subject to terrific hogging strains, and its life is relatively short. No doubt its evolution will proceed and these defects will be remedied in time. Already changes are following in rapid sequence.

Financing

The larger tuna boats cost very roughly \$1,000 per foot of length. As a general rule the construction is financed by the crew and the cannery to which the boat will deliver. A group of successful fishermen will pool their savings to the extent of \$20,000 to \$30,000 and negotiate with a canner for the financing of a boat. If the canner wants more fish and needs an additional boat, he will enter into a contract with the group of fishermen and arrange to advance the balance needed for the construction of the boat. The crew or part of it thus starts with a minor share in its boat and pays off gradually the borrowed balance from the earnings of the vessel, during which time the men are obligated by their contract to deliver their entire catch to the financing canner. For this purpose 50 to 55 per cent of the gross earnings on each and every trip is set aside to meet interest on the loan, pay insurance, maintenance and other fixed charges and repay principal.

Several thousand dollars of principal are repaid on each successful trip of a larger boat, and with luck and good management (and at present prices) such a boat should repay its borrowed capital in three to five years of fishing. Then the boat is financially "clear" and the original partners, or those remaining, become the sole owners of their boat with liberty to fish for whomsoever they please. In reality, however, the majority of boats are not thus fortunate and may take twice as long to repay their indebtedness. With adverse luck and poor management some never do break clear and remain a liability to their owners. Moreover, few if indeed any of the boats allow for depreciation and if this were figured, the investment from the standpoint of the crew would not be so attractive.

However, this is not the viewpoint of the investing fisherman. He figures that his two or three thousand dollars invested is buying him a steady job, which will at least pay him excellent wages and with luck will enable him to repay his invested money from savings in a year or two. And in this respect his figuring is sound, for the remaining 45 to 50 per cent of the earnings of the boat is divided, after operating expenses for the trip have been deducted, among the crew in equal shares. Each man, irrespective of his interest in the boat, gets a single share,³ and the interested partners in the boat get nothing extra until

³ Recently, and in a few of the newer boats, the captain and the engineer have been allotted a slightly larger share than the remainder of the crew.

the boat is clear. Then and then only do they receive, apart from the fishing share, a return on their investment.

Whereas this is the general mode of financing tuna boats it is by no means universal. Many boats are owned by a single man or family; others have been financed by outside capital with the captain owning a minor interest in the boat. In several cases the original participating owners have failed and lost their equity in the boat, which has then reverted to the canner. Cannery-owned boats with disinterested crews have in general been unsuccessful and in consequence the canners generally turn such boats over to some successful fisherman, who is given the option and encouraged to purchase the boat gradually from the earnings.

A tuna boat is relatively short-lived and after several years of service the maintenance charges go up disproportionately. From the standpoint of a business investment she must therefore pay for herself before this time. Otherwise the combined charges—interest, insurance and maintenance—leave little to apply to principal. Dry rot and worms play havoc with the hull. Machinery wears out under the constant gruelling on the longer trips. Tropical storms and blows in Tehuantepec wrack these overloaded hulls and finally the excessive weights fore and aft tend to “hog” them and subject them to terrific strains; so that it is not at all uncommon for such an older vessel to cost its owners \$20,000 to \$30,000 for a thorough overhaul.

Crew

The men who man and own the tuna boats are of many nationalities. At San Diego, the Portuguese predominate. Japanese and Italians are represented in fair numbers. A few boats are owned and operated by Nordic Americans and one or two by Slavonians. Whatever the nationality of the crew, the arrangement is the same. With few exceptions, all fish on shares. A typical crew comprises a captain, fishermen, engineer, wireless operator and a cook. The captaincy is purely nominal and the job is invariably filled by a partner in, or the operator of the boat. Essentially he is a fishing “boss” who makes or executes the decisions for the crew. With the ability he performs the navigation, but frequently illiteracy compels him to employ a navigator as a fisherman.

The fishermen are the “crew” of the vessel. When not fishing they stand a watch, take the wheel and perform the maintenance work on deck, in addition to repairing and assembling fishing gear. The engineer is a skilled and often certificated man. He is responsible for the satisfactory performance of all machinery and his task is arduous. On most of the larger boats he does no fishing; he has not the time. He nevertheless receives a full share and in some cases more, in recognition of his larger contribution to a successful trip. Many boats carry a skilled assistant engineer but in any event the engineer is assisted by three men picked from the crew. These men, except when actually fishing, stand regular engine room watches and perform the oiling and maintenance work below. Under the direction of the chief they assist in all mechanical repairs and servicing. Essentially they are fishermen, allotted the task of assisting in the engine room in place of sharing in the work on deck.

The wireless operator occupies an anomalous position on board. As an operator he gets a steady salary. If he cares to fish and help with other work, he gets a bonus on the catch or a partial share in addition to his salary. On some boats he gets a full share and no salary. The agreement varies from boat to boat. Similarly the cook is often employed on a salary, in which case he does no work outside the galley. In cases where he gets a share instead, he is expected to fish whenever work permits.

Whatever its composition may be, a successful crew must be capable of hard work when on the fishing grounds, which necessitates brawn and at times endurance. The successful boat is one whose machinery is efficiently operated and maintained: a boat manned by a willing crew and captained by one with fishing experience and judgment and the ability to handle boats and men. The rest is luck.

CATCHING BAIT

Bait is absolutely indispensable to these boats. With it their entire catch is made. Without it they are derelict. Bait to the tunaman is anything that swims that will attract and feed a tuna and anything and almost everything has in times of need been used. More specifically, however, bait consists of those densely schooling and small pelagic fish that will live when crowded and confined within a tank. In California, this means sardines and anchovies, and invariably to a high seas tuna fisherman, the former. In Central American waters bait customarily means anchovettas and occasionally "flat-irons," more correctly thread herring.

Bait is not distributed indiscriminately or uniformly along the coast. Off southern California small sardines occur at many points, usually close inshore in the vicinity of a long sandy beach. However, there are areas of relative abundance, one of which is San Diego Bay and the ocean thereabouts, and in consequence the bulk of the California bait is taken there. Along the coast of Lower California, conditions are quite comparable, with concentrations of small sardines at Ensenada, San Quentin, and along the eastern shore of the Bay of Sebastian Viscaino, Turtle Bay and Magdalena Bay. The Bay of Magdalena is the most consistently productive of all. Moreover, this water mass embraces a secondary inlet, Almejas Bay, which is the most northerly prolific habitat of the anchovetta. So it is Magdalena Bay that supplies the lion's share of bait along this coast, especially to the larger high seas tuna boats.

In the Gulf of California, which is more or less a separate fishing area, rich bait grounds are located at Guaymas and Kino Bay, with secondary and lesser ones at Conception Bay and other points. But beyond Magdalena, going south, there are no important or dependable bait grounds this side of Costa Rica. Here, the Gulf of Nicoya is rivaled in abundance and consistency of bait only by Magdalena Bay; and in consequence of this and the fertile tuna fishing grounds nearby, Puntarenas, the main town on the Gulf, has become the best known and most frequented port along the coast.

Eighteen hundred miles, more or less, separates Magdalena Bay from Puntarenas, and along this stretch there are very few areas where

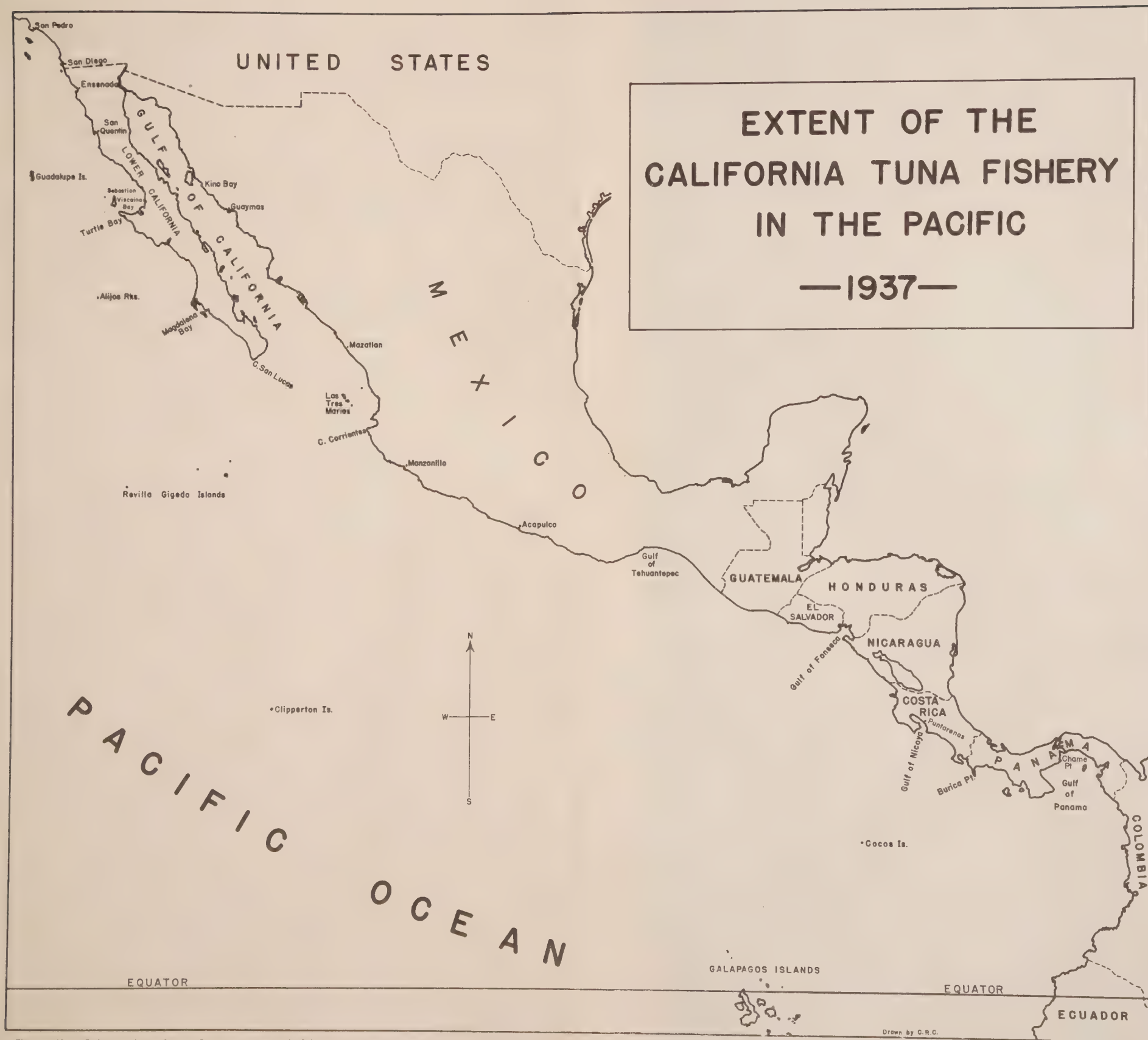


FIG. 7. Map showing the general fishing regions frequented by the California tuna fleet. Fishing grounds are located off the coast of Lower California, in the Gulf of California, off the mainland of Mexico and Central America, and in the vicinity of the various offshore islands.

any bait is taken and then only sporadically. The Gulf of Fonseca, 300 miles northwest of Puntarenas, is a bait ground of decidedly secondary importance. Many of the boats call there, but bait is so erratic in its appearance that if it is neither seen nor taken immediately the boats invariably proceed to Puntarenas without wasting further time.

Beyond Costa Rica there is only one ranking bait ground and this is located in the Gulf of Panama with Chame Point as its focus. This is a most convenient source of bait for those boats making Panama for fuel, but whereas it equals any in fertility it is fished less intensively and more seasonally because the anchovettas here disappear from the flats at times, moving into areas and waters as yet unknown.

Such are the bait grounds *par excellence*. Numerous others are, however, fished at various times. Thus the Galapagos Islands afford bait in limited amounts and of sundry species. The boats, however, rarely depend exclusively upon this supply but invariably secure a full load of bait from the mainland, usually anchovettas from Almejas Bay, before leaving for the islands. They use the local Galapagos bait, which at times is difficult to get, to supplement their catch when their original load of bait is gone.

Bait of whatsoever kind is caught with circle nets. In the early days bait was seined directly from the tuna boat. The school located, the vessel maneuvered into position and encircled, with the net paying out over the stern of the tuna boat. Because of the size of the boats with the consequent large turning radius, the nets were immensely long and cumbersome, approaching as they did a limit of 400 fathoms. Despite this disadvantage it is quite possible that this method of seining bait might have persisted, had it not been for the extension and importance of the more southern tuna fishery. Within the tropics the anchovettas frequent the shallow waters of estuaries or indentations of the coast, where the depth of water is rarely over four fathoms and often less than two. Drawing 12 to 18 feet as these vessels do, they can not scout the flats without the risk of going aground. To scrape the bottom means the removal of the protective copper paint with the invariable consequence of worms in the wooden hull. Furthermore, when cruising in these shallow waters, with the keel perhaps only inches from the muddy bottom, the 8- to 12-inch sea water inlets of the bait pumps, located in the bottom skin of the hull, suck up immense quantities of silt and mud and deposit them, with disastrous results to the bait, with the stream of water into the bait tanks and wells. Even now, with all precautions, inches of silt may collect in the space of a half hour on the floor of the tanks.

It became obvious that other means of seining bait were imperative and gradually the use of these long nets was discontinued and smaller nets substituted, which were hauled directly from a power skiff, until at present the use of power skiffs is universal on the larger boats.

In this method, the tuna boat scouts the whereabouts of bait rather than individual schools. With the mosquito fleet of skiffs and power boat in tow, she cruises in channels safely deep until indications of fish are seen, whereupon she stops and the actual locating and capture of a suitable school or schools is undertaken by the power boat and skiffs. Details vary from boat to boat, though the principle

remains the same. In some cases a power skiff is used with the net piled on a platform in the after end, and the engine out of the way well forward. In other cases a power boat *per se* is used to pull a net skiff, where again the net is piled on a platform aft. The difference is one of preference and nominal. In both cases the net is operated directly from a skiff, with power of its own or power supplied by a motor launch. In either case the net skiff tows a smaller skiff astern with one man aboard it, so that in one case two small boats are used and in the other three.

This entourage selects its school and when in position pays out its net, the end of which is fastened to the smaller skiff with the single man aboard. As the net skiff completes its circle, the loose end of the net is transferred by means of a heaving line from the smallest skiff to the larger net boat. The net skiff carries the bulk of the crew, usually seven or eight men, who now proceed to pull in the net. As the wings are coming in, the man in the small skiff proceeds to the center or bag of the net and there loosely lashes the cork line to the gunwale of the skiff. Meanwhile the power of the launch or skiff is used to offset wind or current and to keep the boat out of its own net and maintain a suitable tension on the cork line. As the net comes in and the fish are crowded into the bag, the smaller skiff fulfills its destiny by compensating with its buoyancy the concentrated weight of fish within the bag which tends to drag the cork line under. With a successful haul completed, the skiffs end up gunwale to gunwale with the bag of the net between and kept apart by means of oars or poles. In this position and if in sufficiently deep water, they signal the tuna vessel which is watching them throughout from a respectful distance and proceed to await its arrival. In cases where the water is too shallow for the tuna boat, the netful of fish must be towed to deeper water and it is in this connection that the preference for the third boat, the purely motor



FIG. 8. The "mosquito fleet" scouting for bait in the Gulf of Nicoya, Costa Rica. The power boat is towing the two skiffs. Note the net in the larger skiff. When a school is located the smaller skiff is cast loose, fast to one end of the net. The power boat tows the seine skiff in a circle about the fish, with the net paying out. With the completion of the circle the end of the net is transferred from the smaller to the net skiff, into which both wings are pulled. Photograph by author.



FIG. 9. Hauling for bait. The wings are in and as the crew pulls in the bag of the net, the bait is gradually concentrated, facilitating the transfer to the tanks. The power boat meanwhile is used to keep the skiff from drifting into the net. The photograph was taken from the small skiff which is lashed to the cork line to prevent the fish from pulling the corks under and thus escaping. Photograph by author.

launch, is justified. For with it the two skiffs may be towed broadside, gunwale to gunwale as they are, without shifting boats or net.

With the arrival of the tuna boat, a heaving line is thrown to the skiff and this made fast to the cork line of the bag. The small skiff now casts loose of the net, which is pulled the intervening distance with the seine skiff to the tuna boat. Here the cork line is taken aboard and fastened to the fishing racks overside, aft, level with the bait tanks. At this stage the net skiff is alongside the tuna boat and held off with poles fore and aft. Between the skiff and the tuna vessel and fastened to the latter by means of the cork line is the bag of the net containing the catch of bait. The next operation is the transfer of the bait from the net to the tanks. A sufficient number of the crew comes aboard from the skiff and with those remaining throughout aboard form one, or more often two, gangs for the transference of bait. The fish are dipped out of the net with a small dip net at the end of a 6- to 8-foot pole by one man (for each gang) standing in the fishing racks. Lifting the scoop from the water, this man swings it as high as he can conveniently to a second man standing on the rail or on a box in the alley. The second man hoists the scoop the remaining distance to the height of the tank top, where it is taken by the next man and passed to the tank coaming. The dip net with the fish is immersed in the water in the tank before it is reversed and the fish liberated. It is the duty of this last man at the coaming to keep tally of the number of scoops received at his tank. A second skeleton chain of men returns the empty dip nets to the man brailing from the fishing rack. With two or more dip nets per gang in constant circulation, the process is continuous and the transfer is conducted with surprising speed. However, every precaution is taken to avoid injury of the bait and for this reason the indi-

vidual scoops of fish are not large. The dip net is usually about half filled, giving an average weight to the scoop of about eight to ten pounds of fish. Practice varies from boat to boat and from time to time to meet contingencies. These statements are generalities.

Bait and bait capacity are measured by the "scoop" and the latter is determined purely by experience. For this reason it would be misleading to express any relationship between weight of fish and volume of water. The quantity of fish held by any tank is a function of a large number of factors, some of which are the capacity of the circulating pumps, the temperature of the water, the species, and the condition of the fish. All are variables; so it behooves the man in charge of bait, usually the chummer, to exercise his experienced judgment in the decision as to how much bait should go into each tank. To take less than the tanks will support means sacrificing fishing time and days; to take more may cause a high mortality in the tank. The capacity of the larger boats is generally between 1000 and 1500 scoops, though three of the newest and largest boats now carry over 2000 scoops.

As soon as the last scoop is aboard, the vessel proceeds to deep clear water to obviate the intake of silt. It is customary, although not always done, to remain at anchor for some hours or a day on or near the bait grounds to allow the bait to "settle." This is particularly advantageous when the fishing is done far from a source of bait. There is always some loss of bait as a result of injury and handling and at times when the condition of the fish is poor or for other obscure reasons the entire load or most of it may die. Therefore anchoring thus for a period of hours gives the crew the opportunity to observe their bait and estimate the survival. Healthy vigorous bait begins to "mill" as soon as it is in the tank or very shortly after, *i.e.*, swim steadily, though slowly in unison around the tank, whereas sickly bait that in all probability will die shortly is more apt to swim at random and less in unison.

Though dead fish decompose rapidly at these high water temperatures, the dead and dying fish first sink to the bottom and remain there until sufficient gaseous products of decomposition have formed to float them. In consequence it is necessary, or at least invariably done, to siphon out the tanks for the first few days after loading bait. This is done with a large-bore, flexible rubber hose long enough to reach from the bottom of the tank, up over the coaming and overside to the ocean level. The end is plugged and the hose filled with water to start the siphon. The end in the tank is attached to a long stout pole, with which a man can manoeuvre the aperture to any point desired. This affords a very practical and efficient way of cleaning the bottom of a tank. Any decomposing fish remaining in the tank are scooped from the surface with a dip net.

The tanks are supplied continuously with a large stream of running sea water taken from the bottom of the hull through an 8- to 12-inch suction. The bait pumps, centrifugal or axial flow type, are in duplicate and are electrically driven. Whereas the arrangement of the piping is inconsequential and varies greatly in the fleet, the incoming stream is always broken by screens or slats or some comparable device, running the length, width or even over one entire face of the tank. This makes for a more diffuse and gentle circulation in the tank, which is apparently essential or at least desirable. Similarly the outlet and

overflow are through an extensive screen or bank of slats. A simple mechanism for controlling the water level is always provided, though at sea the tanks are always full, with water well up into the coaming. In this condition there is no slop and little relative movement in the water mass. These remarks apply equally to bait wells in the hold as to tanks on deck.

The bait is fed regularly once or twice a day. The mainstay of their diet is raw ground-up fish—skipjack, tuna or anything available—supplemented by the specific whims or convictions of the crew. Oatmeal, bread or flapjacks—nothing is amiss. Healthy bait will eat rapidly and will mill at the surface at the time of feeding. Feeding is evidenced by the opening of the gills and the expansion of the mouth. Once acclimated to the tanks, bait will swim through and literally eat from one's cupped hand.

The quantity of bait used varies tremendously from trip to trip. Roughly it varies inversely with the rate at which the load of tuna comes aboard. When tuna are plentiful and readily take a hook, or "biting" as the fishermen say, a single load of bait or even a fraction of a load will suffice to load a vessel. On the other hand when fish are scarce or "won't bite," to use a fishermen's phrase, it may take two, three or more loads of bait to catch a load of tuna. Some crews are frugal with their bait, some chronically extravagant, and not a few criminally wasteful when chumming in close proximity to readily available bait. Good bait is an important link in a tunaman's success, and in consequence the catching and care of bait is an essential part of a tunaman's training. A good all round bait man is one of the most valued assets to a crew.

FISHING TUNA

The tuna vessels scour the eastern Pacific from southern California to the equator, covering a belt from the American mainland to about 800 miles offshore. This zone includes practically all the truly eastern Pacific islands within these latitudes.

In the winter months from November to the end of February, the fleet exploits the Galapagos Islands. Through March, April and May the boats fish the Central American mainland. In June and July they often fish in the Gulf of California and around Cape San Lucas. In August and September the fleet is scattered along the Lower California coast and the neighboring banks and islands as far as Clipperton. Through the fall they mostly revert to the Central American mainland. Whereas this is undoubtedly the general seasonal trend of the fishery throughout the year, it is by no means followed rigorously. Individual boats fish at the discretion of crew or captain, so that at any time tuna boats may be found in almost every area. For it appears that the tuna are somewhat ubiquitous in their distribution and may be found in widely scattered areas simultaneously though not in uniform abundance. Weather conditions and availability of fish and whether they will take a hook or not play a part in determining the movements of the boats.

This fishery is dependent upon two species of fish, the yellowfin tuna primarily and secondarily the skipjack. These two species have

similar habits and the same distribution, and not infrequently school together so that in reality they constitute a single fishery and both are taken indiscriminately by the same vessels. Both are tunas and are sold and marketed as such, though the yellowfin is the mainstay of the fishery and commands a higher price. In consequence the yellowfin tuna are mainly sought, and skipjack taken only incidentally or when yellowfin are scarce or when skipjack are in great abundance and offer the possibility of a short trip; for the skipjack do not keep as well and the losses from spoilage on the longer trips are greater than with tuna. Skipjack are marketed as striped tuna and yellowfin as light meat tuna.

Both species are taken with the same gear, differing only in weight and strength. The gear consists of a bamboo pole with a hook at the end of a six-foot line. The pole averages between eight and nine feet in length, varying with the size of the fish and the preference of the fisherman. At the base it is of a size to afford a good firm hand grip, approximating two inches or less in diameter. The taper is upward and at the end it is perhaps three-quarters to one inch in diameter. The joints of the segments are rasped smooth and at the end of the pole a loop of heavy linen line is seized, to which the short line is knotted. The actual line is in two parts. Fastened to the linen loop on the pole is a $2\frac{1}{2}$ - to 3-foot length of heavy cotton line and to this is fastened a two-foot wire leader which bears the hook. The attachment of line to leader may be direct by looping the eye of the leader through a bight in the line, or it may be indirect through



FIG. 10. Tuna hooks. The one at the left is a striker or squid, the hook set in a brass pipe which is filled with lead and to which white feathers are fastened; this hook is used without bait. When fishing with live bait, the bare hook is used. Various sizes of both types of hooks are used, depending on the size of the tuna. Photograph by D. H. Fry, Jr.



FIG. 11. A two-pole rig. The two heavy cotton lines are attached through swivels to a common ring, to which the leader is fastened. Photograph by author.

an intermediate spiral coil of heavy wire. There are probably as many ways of attaching the leader as there are boats in the fleet, but in all cases the leader is so fastened that it may be readily and rapidly removed and changed. It is never knotted.

The wire leader is invariably in two parts of unequal length, fastened permanently eye to eye. The shorter piece bears the hook and is usually about one-third the total length of the wire leader. This prevents undue kinking of the wire. The wire used is No. 18 to 22 piano wire (diameter 0.041-0.049 inch), the heavier sizes being used with heavier gear.

Two types of hook are used in various sizes to suit the size of fish taken. One consists of a plain galvanized barbless hook, which is inserted through the back muscle of the sardine or anchovetta when fishing with live bait. The other is a similar hook with the shank embedded in tubular brass filled with lead, with feathers projecting

beyond the hook. This is known as a squid or striker and is used whenever the fish will take this lure, as it makes for faster and easier fishing.

Yellowfin tuna range in size from a few pounds to several hundred, though these largest fish are seldom seen. Arbitrary, though legal, limits have been imposed restricting the commercial catch to fish between $7\frac{1}{2}$ and 150 pounds. The skipjack is a smaller fish and rarely attains 30 pounds. With this large range in commercial sizes, the gear used must necessarily be adapted to all sizes of fish, and the adaptation is effected in a simple and ingenious manner. With fish up to 20 or 30 pounds in weight, each man fishes individually with his pole and line. With fish above 30 pounds or thereabouts, the crew pairs into teams. Each member of a team retains his pole but the cotton lines from both poles are linked by means of swivels to a common metal ring, from which hangs by a third swivel a single hook and leader, so that in reality two men, through two poles, are fishing the same line. This is known as two-pole fishing. With fish above 50 or 60 pounds, three lines meet in a common ring and a single hook and this is known as three-pole fishing. Still larger fish are taken with four and five lines running from as many poles to a common hook and leader, thus making four- and five-pole teams. This teamwork takes practice and coordination and at best it is back-breaking work, as each fish must be lifted clear of the water and swung over the 34-inch rail. However, the speed with which a well-drilled team can land their fish is hard to equal by any other means, and when fish are biting well a steady stream of fish comes rapidly aboard until the decks fill up.



FIG. 12. Skipjack have driven a school of bait to the surface where the ever vigilant sea birds are hovering to secure what food they can. The photograph portrays that for which the tuna fisherman is forever watching. In this specific instance, a school of small whales is also preying upon the bait. Photograph by author.



FIG. 13. Chumming a school of tuna. When fish are located, the vessel slows down and the chummer on the bait tank begins to throw out live bait. Chumming continues as long as the fish will bite, the chum serving to retain the school near the boat. Note the "flag" or blanket net in the hatch, in which bait is impounded ready for use. Photograph by author.

It is because of the large size of tuna and because these fish must be lifted manually from the water and swung aboard that the tuna boats have minimized their freeboard aft. Experience has shown that three feet or a trifle less is as high as these larger fish can conveniently be lifted. It is essential to have a solid rail to retain the fish on deck until they are stowed below, so that under present circumstances there is no alternative but to bring the main deck aft down to inches of the ocean level.

Fishing is done, not from the deck, but from racks overside, hinged to the guard rail. These racks are about 6 feet long by $2\frac{1}{2}$ to 3 feet wide. They are constructed from steel rods of $\frac{1}{2}$ -inch square section spaced 2 to $2\frac{1}{2}$ inches apart, welded to heavier end pieces. On the outboard side of each rack is a knee-rest, about 16 to 18 inches high. The racks, being hinged to the guard rail or just above, are so constructed that when not in use they fold up against the bulwarks with the knee-rest overlying the rail. In this position they are clear and out of the way at all times. When in use the racks swing out and are retained in a horizontal position by chain supports.

Tuna and skipjack are schooling fish. Their presence may be detected in a number of ways. At times the fish break water, leaping clear. At other times when near but not breaking the surface they cause a dark and ruffled spot, which on a calm day may be seen at a considerable distance. At other times the presence of a school of fish is revealed at great distances by a flock of birds working overhead. It appears that the tuna in pursuit of food will drive their quarry to the surface. Knowing this the sea birds hover overhead following the school, swooping down when the opportunity serves to pounce upon whatsoever food they can secure. Thus to the tuna fisherman the sea birds are a blessing, for "working birds" invariably mean fish.

In southern waters from Cape San Lucas south, tuna are often found with porpoise so that a tuna boat never passes a school of porpoise without investigation. There seems to be a symbiotic relationship between the two. From observations it appears that the porpoise follow tuna, preying upon whatsoever food the tuna find. This is especially true in the more southern Central American waters where off the mainland tuna is nearly always found with porpoise.

Howsoever the fish are located, the methods of fishing remain the same. Upon sighting a school, the course is changed to intercept the fish. On near approach, the vessel is slowed and simultaneously bait from the tanks is thrown overboard. This is the duty of the chummer. On some boats there is only one chummer, but on most large boats there are two. These men are in charge of the bait. It is their responsibility to keep the tanks cleaned and siphoned and in good repair, to feed and generally take care of the welfare of the bait. Approaching a school



FIG. 14. Tuna fishing. The men are standing in the fishing racks, catching one-pole yellowfin. The man in the foreground is putting a live bait on the hook. Note the porpoise rolling in the background. Porpoise frequently accompany tuna so that the fishermen always keep a sharp lookout for them. Photograph by author.

of tuna, they impound a supply of bait within a small "flag" or blanket net in the coaming of each tank. As soon as the engines are throttled down, they dip from the tank with a small hand dip net a half dozen living fish—sardines, anchovettas, or whatsoever bait they have—and throw these individually or collectively overboard to attract the tuna to the boat. The crew is standing by and all eyes are focussed on the wake of the vessel watching for the "breaks." If the tuna are "biting," they will swoop upon the bait with incredible velocity, and near the surface this rush causes an eddying "slick" upon the surface. With the first "break" the engines are stopped and the crew clambers overside into the racks with either one-, two- or three-pole gear, depending upon the estimated size of the fish. Fishing begins immediately or as soon as sufficient way is lost, for no man can stop the rush of a large tuna with the vessel moving fast. Each fisherman stands loosely braced with one knee against the support upon the rack, with the other foot back against the hull. The base of the pole rests in a pad in or just below the groin, and hung from a belt or strap about the waist. This pad is an improvised affair made of leather, discarded machine belting, burlap or canvas. Each fisherman makes his own, according to his preferences, but some kind of protection to the groin is essential when fishing two- and three-pole fish. The base of the pole rests in this pad with one hand gripping the pole near its end. The other hand extends approximately shoulder high and grips the pole farther out. The tip of the pole is lowered until the hook is immersed a foot or so in water and trailed when the boat is moving. When the vessel finally stops, the pole is moved in short arcs so that the feathered striker simulates a living fish.

Meanwhile the chummers heave bait continuously overboard and the tuna, if they are biting, take living bait and strikers indiscriminantly. The eyes of every fisherman are glued to his striker and as a fish strikes the fisherman leans back on his pole, utilizing the initial rush of the fish to lift it out of water and swing it aboard. The reason for the exclusive use of barbless hooks is now apparent; for as the fish comes hurtling through the air the fisherman suddenly relaxes his tension on the pole and in two times out of three, the hook falls clear of the fish which hits the tank and drops free into the alley. Back goes the striker into the water, ready for the next fish. In a fast biting school there is a steady rain of fish upon the decks, and it is not uncommon to take 30 to 40 tons in an hour or two. One case is on record where a single boat took over 100 tons of tuna in a single day.

Such is not the rule, however. On an average trip, a crew will count upon two or three "good" days of fishing with a daily catch of 20 to 50 tons. The balance of the catch is less sensational and at times heart-breakingly slow. It is far more common to get a ton or two from the first attack into a fresh school, with returns dwindling upon each successive try. For tuna fishing is never a continuous process. The school will stay with a boat for an interval varying from a few minutes to half an hour, and then suddenly will move on or down. The tuna boat then pursues the school if it remains at the surface, chums it up again and starts to fish. If the fish will not bite, the vessel after two or three such tries will abandon it and seek another.

At times the tuna will voraciously devour the chum but will not touch a striker. At such times, live bait is used on a plain hook. In the rail aft and extending 10 to 12 inches into the broad bulwarks of the vessel are a number of little wells, one or two to each fishing rack. These little wells are piped to the bait tanks and supplied therefrom by a gravity flow with running sea water. When live bait is used on the hook, the chummer or usually a fisherman designated to this job passes to each fisherman a small scoop full of bait which the latter dumps into the nearest little well in the rail. Taking a single fish, he then baits his hook and proceeds to fish as described above, except that when using bait upon the hook, the pole is generally held still, allowing the bait upon the hook to swim as it will.

Fishing with live bait upon the hook is considerably slower than the striker method. The hook must be rebaited each time and furthermore the hook does not free from the captured fish as readily as the heavy striker, often necessitating a struggle with the landed fish to clear the hook. In consequence this method is used only when the squid fail.

Sometimes the tuna will take the chum but will neither touch a striker nor even the live bait upon the hooks. At other times the tuna will not even condescend to touch the chum thrown out and there is no

alternative but to leave the school in search of others or even go elsewhere. For days on end a boat may cruise through schools of tuna and hardly get a strike. At such times life is hard. Added to the deadly monotony of this idleness and the anxiety as to the outcome of the trip are the annoyance and discomfort of the frequent false alarms. Every school must be tried and the days are spent clambering in and out of the fishing racks to get drenched with spray and smeared with blood and slime by the miserable half dozen or so fish taken, then stand by again in this discomfort for another call. From dawn to dark this goes on and a week of this will weary anyone. In the log book of a tuna boat will be seen repeatedly the statement: "Lots of fish—won't bite," and to one who

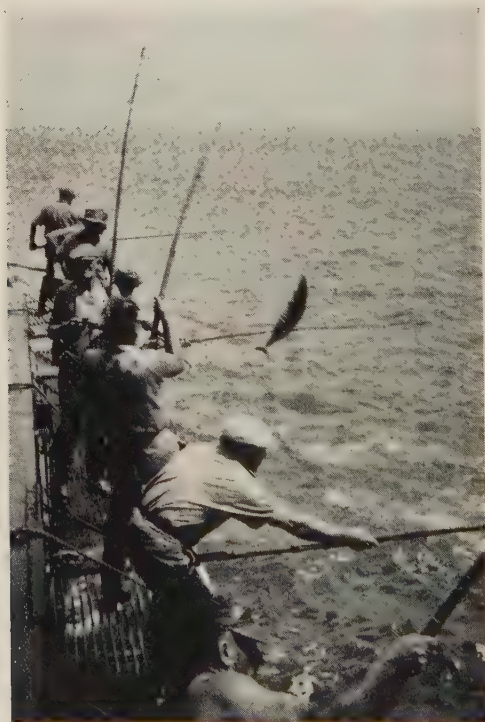


FIG. 15. One-pole tuna fishing. The fishermen are always tense and alert while fishing, as a strike may come at any moment. Photograph by author.



FIG. 16. Skipjack fishing. The deck alongside the bait tank is rapidly filling with fish. Photograph by author.

knows, this terse excerpt tells a tale of an irritated crew in enforced exasperated idleness with the days and profits slipping by.

Actual tuna fishing is a strenuous job, but even to a fisherman it is exciting. When the fish are biting it is a case of "all hands" and every ounce of strength and energy is exerted to get as much as possible from the school. There is always humor and hazard to add to the excitement, and spirits rise in proportion to the catch—up to a certain point. Beyond that there is exhaustion when all hands crawl into bunks as soon as work is done. To a novice it is an experience never to be forgotten. With fish literally raining on deck, the tuna sometimes strike like a bullet before the hook is fairly in the water. With muscles aching and grip benumbed, the fisherman instantly bears back against the bending pole, using weight and the muscles of the arm and back to offset the momentum of the fish. If sufficient strength is there and the pole withstands the strain, the fish flies through the air to hit the tank with a resounding thud and land on deck. Straight one-, two- or three-pole fishing is a relatively simple matter, but hardest of all is fishing a school of mixed sizes. A ten-pound fish may be followed by one of a hundred pounds and more and at such times gear is lost and broken wholesale, and not infrequently men go overboard. Taken off guard, one of two things happens: either pole or man—occasionally all three or four men of a fishing team—goes overboard. At such times boats may be almost cleaned of fishing gear and stories are current of boats that after such an ordeal have cruised around in search of fishing poles instead of fish.

Tuna fishing is not as a rule continuous. It occurs in spurts of relatively short duration, and the intervals between are utilized to



FIG. 17. Two-pole tuna fishing. When the alleyway fills up, it is necessary to move the catch forward. Part of the crew is thus engaged. Photograph by Jack Holroyd.

“trim” the fish on deck. The fish are passed forward from the alleyway between tanks and rail where they are landed, to the deck about the hatch leading to the hold. The alleyways are cleared whenever possible, in preparation for the next school and the fish retained forward by means of boards. Thus gradually the decks fill up and on days when fishing is brisk, fishing may continue until the entire deck and alley-



FIG. 18. Three-pole fishing for large tuna. Note the teamwork of the men catching the fish. Photograph by author.

ways are full, level with the rail. More often, however, and always when fishing is slow and schools far between, each individual catch is passed below for storage as soon as fishing ceases. Under such circumstances most boats will "ice down" or stow their fish two or three times a day, so that fish do not remain on deck longer than necessary. For a tuna fisherman not only has to find and catch his fish, but he has further to preserve them; and he is paid, not for what he catches but for what he delivers in good condition.

PRESERVATION OF THE CATCH

The vessel used as a basis of this description will carry 200 tons of fish, more or less. Three-fourths of this will be carried in ice within the hold. The remainder of the load is carried in the bait tanks or wells in "brine." The earlier catches go in the hold, the last in brine. When fishing is over for the day or time the crew "ices down." Fishing clothes are removed and rinsed in salt water to remove the blood and slime. The crew washes and puts on clean dry clothes, using woolen underwear and heavy clothing to protect them from the cold of the refrigerated hold. Finally, donned in oilskins and sea boots, they go below through the opened hatch.

The hold is divided into bins with removable board partitions, and two or more bins, usually port and starboard of a pair, are worked together. All ice is shovelled from a bin into empty available space until only a four- to six-inch layer on the floor remains. Then fish are called for and slid below on wooden slides by three or four men that remain on deck. The largest fish are always passed down first and loaded on the bottom of a bin. The fish are laid out neatly and compactly in rows until the tier is complete, when a layer of ice is shovelled over the entire tier, filling all the interspaces between the fish and covering them completely. Then another tier of fish is laid, followed by a succeeding tier of ice. Thus alternating tiers of ice and fish succeed until the bin is full.

The initial heat of the fish is removed partly by the coils and partly by the latent heat of fusion of the ice. This melting ice causes a slight settling of the load in each bin. A few days after each bin is completely loaded, the crew "tops off." This consists of adding another tier of fish, if there is room, on top between the surface of the ice and the coils overhead. Whenever refrigeration conditions in the hold are poor there is usually considerable settling of the load and invariably considerable loss of fish from spoilage. But, when everything is working efficiently the degree of settling is relatively small.

As a bin is filled, the next one or pair to be used is cleared of ice which is shovelled back again as the fish are loaded. On all boats the aftermost bins are loaded first and then the crew works toward the hatch from fore and aft. The bin beneath the hatch is the last to fill and then it is necessary to transfer ice to the deck to provide working space.

On the majority of boats using both brine and ice, the hold is completely loaded before the bait tanks or wells are used. Being equipped with brine, no ice is involved and here it is merely a matter of chilling the sea water preparatory to loading fish. As the hold fills up, the well

or tank, whichever it may be, is emptied, the remaining bait being moved to the after tanks. The tank is washed out, then the outlet plugged. In some boats temporary partitions are installed amidships in the tank to prevent undue movement of the fish within. Then it is filled or partly filled with sea water, which is circulated continuously through the brine cooler and thus chilled. The water is brought down to a temperature of 28 to 32 degrees F. and the tank is now ready to receive the load. After the hold is full, subsequent catches go directly to the tank. Fish destined for the tank are washed carefully with a hose to remove slime and blood so as not to foul the water unnecessarily. They are then loaded into boxes and thus hoisted to and dumped into the chilled water in the tank.

All fish, whether loaded in ice or brine, are stowed "in the round," that is with heads on and uncleaned just as they come from the water. This has always been the practice and gives satisfactory results. Even though it were practical, it is doubtful whether removal of the entrails would improve the keeping qualities, for it has been demonstrated elsewhere that in general a "cleaned" fish does not keep as well on ice unless the cleaning job is meticulous and thorough, with gills and entrails entirely removed and all blood and slime washed off. On the tuna boats there is an inevitable loss of fish from physical injury and spoilage. Where coils and lines are clean and all machinery running efficiently and the period of storage not unduly long, the loss is small and negligible, but whenever a boat makes an unusually protracted trip or when machinery fails or circulating coils foul up, the loss of fish may run to 100 per cent of the load. Needless to say, this is exceptional and the average loss of fish from all causes over a period of a year for the larger boats is in the neighborhood of six to eight per cent.

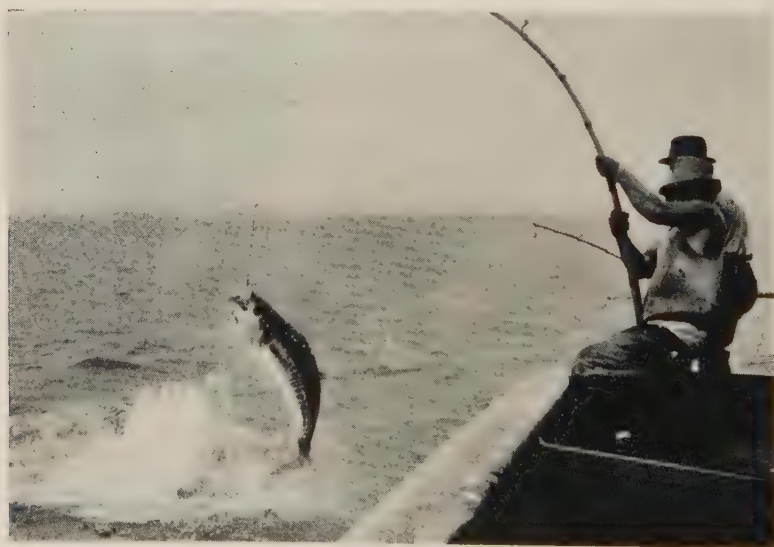


FIG. 19. Catching a large tuna on one pole. This is a two-pole fish. Occasionally schools are of mixed sizes, which makes fishing hard and hazardous. At such times much gear is lost and not infrequently men go overboard. Photograph by author.

DISPOSAL OF THE CATCH

When at last the holds and tanks are full, the vessel starts home immediately. When the trip is unduly long, when fish are scarce or when bait runs out with the hold almost full, a vessel frequently starts home with a partial load. On the long run home from the equatorial ground, the time is spent overhauling fishing gear and on odd jobs of maintenance and repair. At Cape San Lucas or thereabouts a wireless message is sent to the cannery, notifying them of the time of arrival and the size of the load. Passing through quarantine and customs, the vessel proceeds directly to the cannery dock, for the entire catch of yellowfin tuna and skipjack is used for canning.

There are a dozen plants, more or less, packing tuna and the method of unloading varies from plant to plant. At San Diego and at Long Beach each plant has its private dock and here the fish are hoisted from the hold and dumped into water flumes or mechanical conveyors. At Los Angeles Harbor (Terminal Island and Wilmington) a public thoroughfare intervenes between the docks and canneries and because of this the fish are loaded into wooden or metal trucks, which with their loads are wheeled across the street into the plants. In all cases the fish are then washed, either sprayed or hosed. At some point in the unloading or in the conveyor line, the fish are weighed in batches and a member of the crew is always at the scales to record the weights.

Coming into the cannery, the fish are next butchered, which consists simply of opening up the belly and removing all the viscera, after which the body cavity is washed. The butchering is done on butchering tables or directly on the conveyor. Sometimes when the fish are very large they are cut in two.

Frozen fish can not be butchered and because a certain proportion of the "iced" fish comes in frozen, it is necessary to segregate these for thawing. Until recently it was the universal practice to lay out these fish in rows upon a concrete floor, where they were hosed with cold water at frequent intervals, until they had thawed sufficiently to clean and cook. Recently, however, thawing tanks have been installed in some of the larger plants. These tanks are filled with running sea water and into this the frozen fish are dumped to thaw. It is claimed that thawing by this means is more uniform and rapid. When once the fish have thawed they are handled exactly as the unfrozen fish.

As each fish is eviscerated and washed it is lifted from the table or conveyor and placed in a wire basket, $2\frac{1}{2}$ feet long by 15 inches wide. Each basket will hold as many as six small fish, with proportionately fewer as the size of fish increases. Each filled basket is loaded in turn on a truck, especially built to hold about 14 baskets. Each filled truck is then wheeled into a large steam cooker, into which the trucks closely fit, with the wheels on rails. These cookers are of two sizes, approximately 13 and 20 feet long and accommodate five and eight trucks, respectively. The length of the "cook" varies with the size of the fish, from about $1\frac{1}{2}$ to 5 hours or more.

After cooking for the desired length of time, the trucks of fish are wheeled out and left to cool for a number of hours. When the fish are thoroughly cooled throughout, they are taken to cleaning tables.

Here the white meat is separated in four long sections (corresponding to the dorsal and ventral musculature on each side) from the bones, skin and the small amount of darker meat present laterally in the tunas. These bundles of white meat are placed on wooden trays and taken to a mechanical cutter which cuts the fish into lengths which exactly fit the can. The fish is packed by hand into cans, and the filled cans are taken by conveyor (through an exhaust box where no vacuum closing machine is used) to the closing machines, each can receiving en route a ration of salt and salad oil. The sealed cans are collected in rectangular or oval steel baskets, which when full are wheeled to the retorts for final sterilization. After cooling and a wash to remove adhering oil, they pass to the warehouse from which they emerge in attractive labels en route to every part of the United States.

The raw product and every stage of its processing is rigidly supervised by state officials. The raw fish are inspected as they come from the boat to the cannery and any obviously spoiled or damaged fish are rejected. All such rejected fish are weighed and the total rejected poundage deducted from the earnings of the boat. Such rejected fish (with the skin, bones and scrap from the cleaning tables) are converted into meal and oil.

Where any doubt exists about the quality of the fish, such fish are butchered and cooked separately and the final appraisal of the quality is based on the appearance, color and odor of the cooked product. The poundage of fish rejected after cooking is multiplied by an accepted factor and this total again deducted from the earnings of the boat. A final check on the quality of every pack is made by extensive random sampling of the canned fish. The samples are taken to the office of the State Board of Health and there opened and tested; and not until this test is satisfactorily passed is the pack released from the canner's warehouse.

All food products crossing state lines are further subject to federal inspection; and because every can of tuna is as apt as not to be sold beyond the state, the entire pack of tuna must conform to the highest standards. Whereas this has undoubtedly worked to the immediate loss of the tuna fisherman in specific instances, it has in general proved the salvation of the industry for the assured and standard quality of the pack has contributed immensely to the steady healthy growth of the tuna industry. It has, moreover, stimulated efforts to improve the storage conditions on the boats and prevented laxity in the care of the tuna by the fishermen. The quality of the pack is satisfactory but rising standards will necessitate progress in the preservation of the catch.

As soon as the entire catch is landed, the tanks, wells and hold of the vessel are thoroughly washed and scrubbed. The bilge is scoured and generally salt is sprinkled in the bilge and hold. Though not sterile the tuna boats are kept meticulously clean and on a well kept boat there is a barely perceptible smell of fish in the empty hold.

While the boat is thus being cleaned, necessary repairs are being effected to machinery and hull. Every second or third trip the boats go on the ways for bottom painting. This is most essential because of the danger of worms getting in the wooden hull. As soon as all

repairs are effected the boat takes on fuel, ice and provisions, and once more she is outward bound on another trip. The stay in port is short, and except for major annual overhauls it seldom exceeds a week or ten days at the most.

THE PRESENT TUNA FLEET

The foregoing story of the tuna fishery is told in terms of an average high seas tuna boat. This average is based on a fleet of nearly 70 vessels, and for completeness and interest the names of the vessels with their approximate dimensions are listed below. The fleet is changing constantly by the addition of new boats and the loss of older ones. It should therefore be clearly understood that any list is valid only at a stated time. The following is compiled from those boats active, actually fishing and having made at least one delivery on or before June 30, 1937.

LARGE TUNA BOATS

Boat name	Fish and Game number	Approximate length in feet
Alert	3540	97
Atlantic	3740	110
Belle of Portugal	3913	130
Cabrillo	3843	135
California	3687	116
Cape San Vincente	3838	125
Chicken of the Sea	2234	120
Cipango	2092	102
City of San Diego	3778	124
City of San Francisco	3796	92
Columbus	2279	107
Conte Bianco	3830	112
Defender	3720	108
Emma R. S.	3704	95
Europa	3686	117
Fisherman II	3497	183
Flying Cloud	3640	105
Funchal	3701	106
Glory of the Seas	3713	117
Invader	3547	118
Jenny Rose	2122	106
Lusitania	3680	100
Magellan	3626	102
Marico	2085	105
Mayflower	3786	135
Navigator	3702	113
Northwestern	3706	117
Olympic	2840	118
Patria	3574	125
Picaroto	3914	128
Progress	2492	95
Rajo	3723	116
Reliance	2638	125
Sacramento	3608	112
St. Therese	3610	95
San Rafael	3743	123
San Salvador	3590	122
Santa Cruz	3681	105
Santa Margarita	2739	99
Santo Amaro	3629	112
Sao Joao	3643	114
Sea Boy	3051	111
Sea Tern	2080	105
Shasta	3639	96
Southern Cross	2670	118
Stella di Genova	3744	110
Taiyo	3651	111
Vantuna	3886	102
White Star	2564	105



FIG. 20. One of the small "local" tuna boats fishing off Turtle Bay, Lower California. Photograph by Richard S. Croker.

This fleet or its equivalent delivered in 1936 approximately 74 per cent (77,606,698 pounds) of the total catch of yellowfin tuna and skipjack. Eight per cent (8,574,003 pounds) was delivered by a small fleet of smaller live bait boats which fish tuna and skipjack throughout the greater part of the year but not exclusively. Because of their smaller size and lesser cruising radius they are seasonally compelled to fish for other species such as yellowtail and bonito when tuna are beyond their range. However, they are essentially tuna boats, built as such and with a qualification as to size they are equally described by the foregoing sketch.

In the past two years this fleet has been increasing rapidly in number. A rising demand for yellowtail and bonito, which may be taken profitably by smaller boats in the season when tuna and skipjack are not available to them, has contributed to the growing popularity of tuna vessels approximating 70 to 80 feet in length. Consequently the catch of tuna and skipjack by this fleet of smaller boats promises to rise in magnitude and importance. A catch of only eight per cent by this fleet is not therefore truly representative, for in the appended list of 26 boats comprising the fleet as of June 30, 1937, only 15 were operating throughout 1936. Four others were commissioned in the latter half of the year, whereas the remaining number joined the fleet gradually in the first half of 1937.

SMALL TUNA BOATS

Boat name	Fish and Game number	Approximate length in feet
Ambassador	1670	70
Amor da Patria	3661	75
Anna K.	3907	50
Balboa	3631	65
Benita	3909	90
Destiny	3915	80
Donna Jo	3866	65
Electra	3917	53
Genoa	3587	49
Golden Gate	3902	75
Marie Louise	3919	73
Oceana	3516	65
Olympia	3685	84
Osprey	3652	65
Princess	3679	55
Ranger	3893	69
Rome	3654	59
Rose Marie	3916	62
Sachtleben	3911	57
St. Anthony	3901	64
Santa Ines	3912	81
Senator	2193	88
Venetian	3850	65
Vigilant	3676	46
Western Enterprise	2093	87
White Star	3598	51

In this case, the list is somewhat arbitrary for it is impossible to segregate sharply the older smaller tuna boats from a host of similar general live bait boats that fish tuna sporadically when the runs are good. The latter class of vessels and a large fleet of purse seiners operating in the late spring and summer off the coast of Lower California contributed the remaining 18 per cent of the catch in 1936.

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